BOSTON UNIVERSITY
JOURNAL OF EDUCATION
Established 1875

VOLUME 141 FEBRUARY, 1959 NUMBER 3

Visual Handicaps to Reading

THOMAS H. EAMES

TABLE OF CONTENTS

Introduction 2

Seeing to Read 3

Discussion of Eye Handicaps to Reading 5

Summary of a Comparative Study of Eye Conditions among Reading Failures and Unselected Pupils 25

Classroom Help for the Child with Eye Difficulties 30

Eye Screening Test 31

Published four times a year (October, December, February, and April) by Boston University School of Education, 332 Bay State Road, Boston 15, Massachusetts. Subscription price $3.00 a year; 2 years, $5.50. (In Canada, $3.50 a year; foreign, $4.00 a year.) Single copies $1.00. Entered as second-class matter, Boston, Massachusetts, October 30, 1953. Change of address should be sent promptly, giving both the old and the new address. Copyright, 1959, Trustees of Boston University. All rights reserved.

INTRODUCTION

A cumulative study of physical handicaps to learning has been carried on by this author for many years. It is unusual in that it covers an area where education, psychology, and medicine overlap. The work has been directed and the examinations and tests have been made in almost every case by the author who is a registered physician as well as an educator, particularly interested in the problems of the learning of reading.

The cases were drawn from those seen by the author at the Harvard Psycho-educational Clinic, Boston University Educational Clinic, various school surveys made by him, and from private cases. The present number involved is 3,500, of which half are reading failures and half are unselected school children, both groups ranging in age from 5 through 17 years of age. The median IQs of the two groups are 102 and 109 respectively. The sex frequency differs between them. The reading failures are 20% girls and 80% boys, which reflects the usual incidence of language difficulties, while the unselected group is 46% girls and 54% boys. About one hundred reports of research done in these groups have appeared in various educational, psychological, and medical journals.

The part of this study which concerns the comparative eye condition of reading failure and unselected groups of school children is summarized in the following pages. There is also an introductory section on the physiology of seeing to read and another in which educational indications and implications of the conditions reported are discussed.

Visual Handicaps to Reading

SEEING TO READ

The teacher who understands the physiological processes in seeing and the handicaps that may interfere with it, not only appreciates the pupil's difficult task in learning to read but can see through many common errors and help the pupil to overcome them. She can also detect many signs and symptoms of visual and ocular handicaps and request appropriate professional attention for them. In addition to this she is prepared to adapt her assignments to the visual capacity of her pupils.

Vision is a psychological act that occurs in the brain as a result of nerve impulses sent there from the two eyes, which are nothing more than complex receptor organs.

Each one is a round, ball-like structure, protected on the outside by a tough, white covering (the Sclera) and lined with a dark membrane (the Choroid) which serves to keep light from coming through the wall, just as the black paper lining of a camera does. On the inside, next to the choroid, lies the Retina, which contains the receptor cells themselves (rods and cones). These cells are connected with the brain by retinal and optic nerve fibers.

There is a transparent window in the front of the eye (Cornea) beneath which lies the part that gives the eye color (Iris), in the middle of which is an opening (Pupil) that appears black to the observer. The iris regulates the amount of light entering the eye by making the pupil larger or smaller, just as the iris in a camera does, while behind the iris there is a lens that focuses the eye.

The ciliary muscles can make the lens bulge and so regulate the focus for different distances (accommodation). When a person reads or does desk work the lens is held in a bulged position to shorten the focus but when looking across the room it relaxes. Some children who are accused of looking off into space and day-dreaming have conditions that tire the ciliary muscles more rapidly than the others and so they gaze out the window to relax and rest them, without being aware of why they do it.

The area between the cornea and the lens contains a watery substance (aqueous humor), while the large space between the lens and the retina is occupied by the vitreous humor, somewhat resembling thin gelatine. These media give the eye internal support and hold it in shape.

When an eye looks at anything the light reflected from that object enters through the cornea, pupil, and lens. The lens focuses the light on the retina and forms an image or light-stimulus pattern. The retinal receptor cells on which this pattern falls are activated and send nerve impulses to the brain. Meanwhile the other eye is doing the same thing.

Each eye must be aimed in such a way that the image will fall on corresponding retinal points in each so that the nerve impulses sent to the brain will form an accurate, composite pattern in the visual area (fusion). The aiming is done by six rein-like muscles, attached to the outside of each eye. They control and coordinate eye movements in all directions.

When a child looks at a word he aims both eyes at it (convergence), and his lenses bulge enough to bring it into focus (accommodation). His

eyes move along the line in jumps and pauses, each jump ending in a new fixation. This requires very exact coordination of both convergence and accommodation. Failure to do this accurately accounts for many errors.

Each eye is connected with the brain by an optic nerve, derived from the retina, which emerges from the back of the eye. Impulses arising in the retina when one looks at anything, pass back to the brain over the optic nerves, each of which is a part of a complex visual pathway, connecting the retina with the visual area in the back part of the brain.

The impulse first enters the visuo-sensory area of the occipital lobe (Brodmann 17) [1,2] which is connected with seeing without recognition, thence it moves on to the visuo-psychic areas (Brodmann 18 and 19) concerned with visual organization and association. Area 18 permits recognition of a rather simple nature, while area 19 has to do with a more complex kind of recognition but mainly with visual memory. If the object observed is a word or group of words they are seen but not recognized as such in area 17. They are recognized as *word forms* in areas 18 and 19, but their *meaning* is not comprehended until the angular gyrus of the inferior parietal lobe is reached (area 39). This part of the brain has to do with the *interpretation of symbols* (letters, words, syllables) and combines the functions of *recognition and visual memory* for word forms. It is well known in neurology that a lesion here will interfere with the ability to read.[3, 4]

Since interference with seeing the print will make it hard for the child to learn to read, it is necessary to examine this complex visual system for defects, deficiencies, or diseases which may impair, prevent, or pervert its normal functions.

There are individual differences in the degree to which any given visual impediment may affect the pupil's reading. One child will learn to read in spite of a rather serious visual difficulty while another will be greatly handicapped by a similar condition and make little or no progress with reading until it is overcome. A relatively unimportant eye defect sometimes proves to be a greater reading handicap to one child than a much more serious one does to another.

There are many different causes of inefficient vision. They include lesions of the visual areas in the brain, the tracts connecting the brain with the eyes, including the optic nerves, and defects and diseases of the eyes themselves. Some of these difficulties can be overcome by the use of glasses, others by medical or surgical treatment and occasionally by exercise, while others cannot be helped. There are eye conditions that do not reduce the sharpness of vision below the normal level, as determined by tests, but which make the visual act more difficult. They often result in rapid fatigue in reading and predispose to trouble in completing reading assignments among upper-grade pupils and poor reading ability or difficulty in learning to read among elementary school children.

---

[1] Brodmann, K., *Vergleichende Lokalisationslenre der Grosshirnrinde.* Leipsig, J. A. Barth, 1909.

[2] Penfield, W., and Jasper, H., *Epilepsy and the Functional Anatomy of the Human Brain*, Boston, Little Brown & Co., 1954.

[3] Cobb, Stanley, *Borderlands of Psychiatry*, Cambridge, Harvard University Press, 1943, p. 43.

[4] Lyle, D. J., *Neuro-ophthalmology*, Springfield, Ill., Charles C. Thomas, 1945, pp. 49–51.

DISCUSSION OF EYE HANDICAPS TO READING

Defective Vision. Visual deficiencies range from relatively slight amounts to total blindness. Their importance as handicaps to learning have always been recognized but there have been differences in opinion as to how much defectiveness constitutes such a handicap. Some investigators such as Selzer[1] and Blake & Dearborn[2] appear to feel that vision is less adequate among poor readers or that more visual defects occur among them. On the other hand Farris,[3] Monroe,[4] and Stullken[5] are of the opinion that deficient visual acuity is not particularly important as a cause of reading failure. The present author's studies in this field indicate that while visual acuity measurements do not differentiate good and poor readers, individual cases of defective sharpness of vision (visual acuity) especially when of considerable degree are important factors in school failure and should not be overlooked.

The sharpness of vision is usually measured according to the Snellen principle,[6] which is discussed in the section on screening tests. The visual level is determined by the standard line of letters an individual is able to read at a standard distance, usually twenty feet. The score is expressed as a fraction, the numerator of which is the standard distance (usually twenty feet, hence 20) and the denominator is the number of the smallest standard line of type that the child can see. Thus normal vision is 20/20. This means that the testee, standing twenty feet from the test card, sees the standard twenty-foot line. Lower vision is recorded as 20/30, 20/50, 20/150 etc. Children are not born with 20/20 vision. It is immature at birth and gradually develops toward the normal level, and as in the case of all other physiological functions that go through a process of maturation there are age level differences, especially in the younger years, and individual differences within each age.

Taking school children as a group, regardless of age or grade, one finds that about seventy percent of them have normal vision. The others include those whose vision is immature or interfered with by defects or diseases. Fifty percent of the author's school entrants with a chronological age of five years have exhibited normal vision. Berens and Zuckerman[7] reported an even lower figure. This means that in the first year of school, at least, half of the children do not come up to the 20/20 level. Although this is not widely appreciated it is the reason behind the use of larger type in textbooks for the lower grades. The proportion of pupils with normal vision increases slowly up to about the age of 14. It is important for the teacher to know how many pupils have poorer than average vision, which pupils are so affected, which are visually immature or cannot be helped

[1] Selzer, C. A., "Lateral Dominance & Visual Fusion," *Harvard Monographs in Education No. 12*, Harvard University Press, Cambridge, 1933.

[2] Blake, M. B., and Dearborn, W. F., "The Improvement of Reading Habits," *Journal of Higher Education VI*, February 1935, pp. 83–88.

[3] Farris, L. P., "Visual Defects as Factors Influencing Achievement in Reading," *Journal of Experimental Education*, September 1936.

[4] Monroe, Marion, *Children Who Cannot Read*, University of Chicago Press, Chicago, 1932, p. 80.

[5] Stullken, E. H., "Retardation in Reading and the Problem Boy in School," *Elementary English Review, 14*, May 1937.

[6] May, C. H., *Manual of Diseases of the Eye*, Wm. Wood & Co., Baltimore, 1941, p. 12.

[7] Berens, C., and Zuckerman, J., *Diagnostic Examination of the Eye*, J. B. Lippincott Co., Philadelphia, 1946, p. 452.

by medical or other treatment and which can have better vision with glasses or treatment. Her interest is partly to avoid the mistake of expecting children with low vision to compete with normally seeing classmates and partly to bring those with remediable eye defects to the attention of parents and doctors, so that they may be helped to make the most of their potentialities. Locating these pupils is best done by requiring a complete eye examination for each school entrant or, if this is not possible, by the use of an eye screening test which is intended to pick out the majority of those who should have a professional eye examination.

There are many causes of low vision. As a matter of fact it is a symptom of a great many different defects and diseases of the eyes, the brain, and other organs. Sometimes vision is poor but no defect or disease can be found to account for it. This is called amblyopia (dim vision). Among the author's cases it occurred in twelve percent of the unselected pupils and was slightly more frequent among school failures. It may exist from birth, may result from inhibition of the image of one or both eyes, may be hysterical in character or may result from toxins or immaturity as well as other causes. The hysteric type is fairly common among children who are upset over continued school failure. These latter conscientiously believe that they cannot see and excuse themselves for failure on that basis. When shown that they can succeed and when given intelligent reassurance and remedial teaching or other effective pedagogic help, they usually recover rapidly.

The child with amblyopia is likely to tire quickly if the visual defect is considerable, become inattentive and irritable, and may not be able to retain what is presented toward the end of the practice period. He is likely to have trouble in seeing the board or his books, especially if the type is small and the light poor. He may make errors in copying from the board or working from finely printed texts. Some who can see the text are unable to see the more finely printed footnotes. Glasses are sometimes given to children with amblyopia but *they do not raise vision to normal*, although they may improve it somewhat if refractive error coexists. The fact that glasses do not always afford the child normal vision must be repeated over and over because many parents and teachers still believe that once a child has been provided with them his vision is as good as that of his classmates. Very often it is not. Glasses only put poorly focusing eyes into focus or relieve strain. They do not increase the sensitivity of the eye.

Refractive Error. An eye that is in perfect focus for distant seeing when at rest is said to be emmetropic. This is an ideal condition seldom found but often approximated. When emmetropia does not exist the condition is one of ametropia (imperfect focus). Generally speaking, the eyes of infants tend to be far-sighted (hypermetropic) but as the child grows the eye develops toward emmetropia and exhibits a tendency to become less hypermetropic. If the process stops when the eye reaches the emmetropic stage all is well but if it stops before that point in development has been reached the eye remains hypermetropic but less so than in infancy. Similarly, if development of the eye carries it beyond the emmetropic point it becomes myopic (near-sighted) and tends to become more so until maturity. These changes are going on actively during the elementary school years and sometimes persist after the child has reached the secondary grades. Ordinarily they are over by the time the learner enters college.

School children, particularly those in the lower grades, should be protected from excessive eye strain so as to prevent interference with ocular development.

When a refractive error is present the eye doctor "corrects" it with glasses. The lenses put the resting eye into focus as if it were emmetropic but only while they are being worn. If vision has been impaired by the refractive error the glasses will improve it to the limit of the child's potential visual ability. However, if the retina or other nerve structures involved are not normally sensitive, lenses will not raise vision to normal. They merely bend the light rays enough to make up for the excess or deficiency in refraction of the unaided eye. Lenses do *not* impart sensitivity to visual structures, neither do they cure anything. They make it possible for many visually handicapped children and adults to see well enough, while using them, to do work that would be difficult or impossible otherwise. The three common refractive errors are far-sightedness (hypermetropia), near-sightedness (myopia) and astigmatism. They may exist separately or, in astigmatism, in various combinations of either or both hypermetropia or myopia. When the two eyes differ in the amount or kind of refractive error the condition is called anisometropia.

The Handicap of Hypermetropia (far-sightedness). The hypermetropic eye lacks sufficient refracting power to form a sharply focused image on the retina. It is the commonest refractive error among children of school age. Estimates of the incidence of the condition at this period range from about sixty to eighty percent. However, low degrees of hypermetropia are considered almost physiological and, unless the child has symptoms of eye strain or is failing in school, few doctors give glasses for less than 1 diopter (measure of focal length) of the condition. Among the author's cases hypermetropia of 1 diopter or more occurred in 43% of reading failures and 12% of unselected school children.[8] Hypermetropia may be of developmental origin as described, the refractive power of the eye may be insufficient, or the eyeball may be shorter than the focusing power of the refractive media. Farris,[9] Blake and Dearborn,[10] Taylor,[11] and the author have noted some relationship between hypermetropia and less than average school performance. Traquair[12] has stated that there may be slowness in learning to read among hypermetropic children, which supports some of the findings just cited.

Far-sighted pupils often dislike books, school, and teachers and prefer sports and out-of-door activities. This is because book and desk work impose a greater load on their eyes than does distant seeing on the playing field. In the schoolroom they sometimes become irritable, short-tempered, give poor attention and are disinclined to work as the day goes on. They are likely to make very little effort to complete their school tasks and to gaze out of the window. They do this because it rests their eyes although they seldom recognize the reason. Sometimes they rub their eyes, wrinkle

[8] Eames, T. H., "Comparison of Eye Conditions Among 1000 Reading Failures, 500 Ophthalmic Patients, and 150 Unselected Children," *American Journal of Ophthalmology, 31,* June 1948, pp. 713–717.

[9] Farris, L. P., Visual Defects as Factors Influencing Achievement in Reading," *California Journal of Secondary Education, 10,* October 1934.

[10] Blake, M. B., and Dearborn, W. F., Op. Cit.

[11] Taylor, E. A., *Controlled Reading,* University of Chicago Press, Chicago, 1937.

[12] Traquair, H. M., *Clinical Ophthalmology,* C. V. Mosby Co., St. Louis, 1948, p. 70.

up their foreheads and seem to be straining to see their books. Occasionally one eye will turn in when the child has become tired but will be straight again in the morning after a night's rest. Some far-sighted children complain of frequent headache and it is not unusual for them to have red lid margins, occasionally with yellowish crusts on them. Rarely they become nauseated after long periods of close application. On the other hand many far-sighted children, especially when the amount of defect is small, may present no symptom or sign that a teacher or parent could be expected to notice.

Hypermetropia has a strong hereditary background, and often becomes troublesome after acute disease or prolonged or unaccustomed close work. It may make itself known for the first time when the child enters school, or later with more extensive use of texts. Sometimes it does not cause much trouble until the more intense load imposed by secondary school or college work is met. Probably the far-sighted child is more easily distracted and harder to motivate than one with almost any other type of eye defect. He is likely to have normal vision insofar as the ability to pass visual acuity tests is concerned. This is because he *compensates* for his inadequate refractive power by using his accommodation constantly and excessively, even in distant vision.

While an emmetropic child only accommodates when doing relatively close work, especially at book and desk distances, the far-sighted child must do as much and *in addition* exert an excessive accommodative effort sufficient to compensate for his refractive deficiency. He can see distant objects easier than he can near objects but he can see *neither* clearly without accommodative compensation, unless he is wearing properly fitted glasses. When the hypermetropia is of high degree it may be impossible for the child to mask it by accommodative effort and then it is easily detected. However there are wide individual differences in the way children react to the various degrees of this defect. A relatively small hypermetropia may mean nothing to a young, healthy child, while the same amount occurring in the eyes of another may cause serious discomfort and inability to perform book and desk work for long periods. The older the pupil the more likely he is to be troubled by his hypermetropia.

The accommodative function is often impaired by febrile illnesses and when this occurs in a hypermetropic individual he may be unable to maintain his compensation for some time after he returns to school. Some moderately far-sighted pupils can get along in school without glasses, some require glasses for reading and close work, while others need them constantly. The decision must rest with the doctor but the teacher may help in a number of ways.

She can report signs of eye difficulty to the school physician or nurse or to the parents. In many schools she may either perform the screening eye test herself or refer her pupil to the school officer responsible for this work. She can reduce the child's book and desk assignments to a minimum until he has seen his doctor. The passage of a screening test does not mean that the child is free from far-sightedness or any other type of eye trouble. It only means that the child's eyes are not defective enough to fail the test. If only the Snellen or other visual acuity test is given many children with hypermetropia sufficient to produce rapid fatigue in close work will be missed. This is because the child is able to compensate for his defect by using an excessive amount of accommodation, thereby focusing his eyes long enough to pass the test. All strict visual acuity

tests such as the Snellen, fail to differentiate hypermetropic cases except when the defect is considerable. Many individuals with enough hypermetropia to cause rapid fatigue in school work are overlooked when such tests are used.

Fortunately improved screening tests for school use have been devised. They detect the presence of hypermetropia in one way or another. This matter will be discussed more fully in a later section on screening tests. Notwithstanding the important role played by such tests in the modern school and educational clinic it must be remembered that no screening device can or should take the place of a doctor's careful eye examination. Even though a pupil may pass a screening test he should have a professional eye examination if symptoms or signs of eye trouble persist.

When school achievement has been impeded by far-sightedness the improvement following correction by the use of glasses is often dramatic. However it may be less so if the child has been failing for a long time. On the other hand some pupils have weak glasses which are of little or no value to them. In fact they may be an actual handicap.[13] Sometimes the far-sighted child will say that he sees better without his glasses and attempts to stop using them. Parents and teachers should not be misled by this because many such children actually *do* see more sharply without their glasses, but for short periods and at the expense of considerable *strain.*

The Myopic (near-sighted) Pupil. When a child is myopic (near-sighted) his distant vision is blurred while near vision is usually good. The eye has more refractive power than is necessary to form an image on the retina and instead the image falls in front of this receptor membrane rather than on it. Light from nearby objects diverges strongly and partially offsets the effect of the excessive refraction so that there is a critical point called the near point (punctum proximum) at and nearer than which the near-sighted child can see clearly. When this point is closer than the usual reading distance the pupil holds his books closer to his eyes than other children do.

Myopia is not more common among reading failures; in fact an amount sufficient to allow the child to work at book or desk distance without accommodating may be favorable in that he can often work at his books for long periods without feeling particularly tired. Farris[14] found myopia associated with better than average performance in reading and the present author has found that myopia occurs about as frequently among reading failures and non-failures. The late Dr. Sanford Gifford[15] formerly professor of ophthalmology at Northwestern University placed the incidence of myopia among adults at 1.5% while 4% of my cases of children of school age exhibited it.

The cause of myopia is somewhat in doubt. One group holds that hereditary factors are the most important, while others believe that faulty posture, poor nutrition and too heavy a study load in school predispose to the development of this refractive condition. Some investi-

[13] Eames, T. H., "The Effect of Glasses for the Correction of Hypermetropia and Myopia on the Speed of Visual Perception of Objects and Words," *Journal of Educational Research, 42,* March 1949, pp. 534–540.

[14] Farris, L. P., Op. Cit.

[15] Gifford, S. R., *A Textbook of Ophthalmology,* 3rd Edition, W. B. Saunders Co., Philadelphia, 1945, p. 53.

gators have suspected endocrine factors but have not proven a direct relationship. The myopic pupil usually has trouble in seeing the blackboard but can see his book and desk work. Sometimes he holds his book close to his face or bends his head close to the paper on which he is writing. He usually likes books and it is hard to tear him away from them. He is not often fond of out-of-door activities or sports.

Children who have been near-sighted from birth or who have gradually developed myopia are not aware that they do not see normally in distant vision and make no complaint. They often make mistakes in copying from the blackboard, like one little fellow who almost always made errors in copying his numberwork but did the examples correctly. The copying error, of course, resulted in the wrong answer for the assigned example. This child was found to be extremely near-sighted. Corrective lenses were prescribed and the boy made no more errors. Near-sightedness allows many pupils to see their books without expending the normal amount of accommodative effort, hence book and desk work seems easy for them, notwithstanding that it is often regarded as prejudicial to their ocular welfare.

Practically all of the eye-screening tests used in schools will pick out myopia very well because it interferes with distant vision. Even the Snellen Test which repeatedly has been shown to be inefficient for general school eye screening, picks up the near-sighted pupils. Myopia tends to increase as the child progresses through the grades and it is a good plan for pupils with the condition to do a minimum of book and desk work or outside reading. Making model airplanes and doing fine fancy work is about as bad. They should be encouraged to participate in out-of-door activities, sports, and physical exercise.

Sometimes myopia progresses very rapidly with serious results. There are many doctors who believe that a heavy school program with considerable book work favors the increase of near-sightedness. Teachers should give the myopic child comparatively light reading assignments, frequent rest periods and not require him to work with poorly printed texts. It is best to find out from the pupil's eye doctor just how much consideration is necessary in each case. Some near-sighted children can carry the usual study load while others should have their work reduced to a minimum.

The Astigmatic Handicap. Astigmatism is an eye defect in which the refractive power varies in different meridians of the eye. For example an astigmatic eye may be refractively normal in one meridian and either far-sighted or near-sighted in another. Likewise another astigmatic eye may be far-sighted in one meridian and more far-sighted in another. A different astigmatic eye may be near-sighted in one meridian and more near-sighted in another. Finally a still different astigmatic eye may be far-sighted in one meridian and near-sighted in another. Among the author's cases astigmatism occurred slightly more often among reading failures. He found astigmatism of one diopter or more in five percent of reading failures. It is often congenital, probably inherited, and is due, in some instances, to irregularity in the curve of the cornea or to irregularity in the lens inside the eye. Changes in the index of refraction of this lens may also cause it but do not appear to be common among children of school age.

Irregularities resulting in astigmatism in children's eyes are sometimes the result of injury or eye diseases which damage the cornea, lens, or

both. Such a case was that of a little boy whose eye was cut deeply across the cornea by a flying piece of metal. After the eye healed completely it was found to be very astigmatic, whereas, before the injury it had been quite normal.

Pupils with astigmatism often dislike close work or anything that requires long periods of discriminating vision at any distance. They tend to become irritable rather early in the school day and may complain of discomfort in and about the eyes. They may find it hard to make straight lines and their writing may run up or down hill and deviate from the line upon which they are expected to write, they may do poorly in art classes and have trouble in getting the effect of perspective. Several who have had this difficulty have gotten over it very dramatically and promptly when their astigmatism was found and proper glasses were prescribed.

Most cases of astigmatism interfere with vision and are detected readily, but a few with low degrees of the defect may be missed in school eye screening. Ordinarily, astigmatism of an important degree makes its presence known by evidences of eye-strain and visual impairment and so, like amblyopia and myopia, important amounts of astigmatism are easily detected by the usual screening techniques. There is not much that a teacher can do for the astigmatic pupil except to put him through the school's eye-screening test and report him for professional eye examination if he fails it or if he seems to be having trouble seeing his work. Until such children have been examined by their eye doctor the teacher should be lenient with them in matters of tasks and assignments.

The School Child Whose Eyes Are Not Mates. The refractive errors, far-sightedness, near-sightedness and astigmatism, do not always occur to the same degree in each eye. One eye may be normal (emmetropic) refractively, while the other is ametropic, i.e., presents one of the refractive errors. Each eye may be far-sighted, near-sighted or astigmatic but one may be more so than the other. In astigmatic cases with the same amount of defect in each eye the *direction* (axis) of astigmatism may differ, the amount of astigmatism may be greater in one than the other but with the same axis, or they may differ in both respects. Sometimes one eye will be far-sighted and the other near-sighted, one will be astigmatic and the other not. In fact a large number of such combinations is possible.

The significant thing to be remembered is that the eyes often differ *in their refraction* (anisometropia) as well as in their individual sensitivity or lack of it. This sometimes predisposes to abnormal conditions of eyedness, suppression of the vision of one eye (sometimes called suspenopsia), deviation (strabismus) of one or both eyes, difference in the size and shape of ocular images, fusion deficiency, and others. Each of these conditions presents characteristic confusions with further disturbances arising from the attempt to *combine and interpret* the two somewhat different pictures that come back to the brain from the two eyes. Anisometropia occurred in six percent of the author's unselected cases and in thirteen percent of his reading failures.

Defects of Binocular Vision in Relation to Reading. Good binocular (two-eyed) vision is one of the elements in readiness for reading. This depends on the relative normalcy of certain brain areas, nerves, eye muscles, and on the eyes themselves. Obviously it would be best to consider all of them

together but for convenience it is necessary to discuss them separately, especially since the results of defectiveness or disease of these various parts are likely to interfere with binocular vision in different ways and to variable degrees.

The eyes must be able to aim at a given object or symbol (such as a word) and to coordinate their aim so that the image formed in each of the two eyes will fall on corresponding points in the two retinae. The nerve impulses arising from the retinal receptors stimulated by these images go to the brain where they are combined, giving rise to a single binocular perceptual image of the object or symbol. This is called fusion. Briefly, it is the blending of the two monocular images into one binocular image. Sometimes fusion ability is deficient. The two eyes may see simultaneously but not as a unit. When this occurs there is likely to be an alternation of fixation from one eye to the other and the child may lose his place in reading work when fixation shifts.[16] Ordinarily the individual avoids the image from the non-fixing eye and suppresses it. When successful in doing so he may have no difficulty with his school work.

Defective vision in one eye, differences in the size and shape of the retinal or cortical images and strabismus are among the other predisposing causes of fusion deficiency. Eighteen percent of the author's unselected children of school age exhibited fusion deficiencies while they occurred in 22 percent of his reading failures. There are no symptoms or signs of fusion deficiency which a teacher or parent might be likely to notice except, perhaps, signs of general eye fatigue. The commonly used Snellen Test of visual acuity does not pick up cases of fusion deficiency but some of the improved eye screening tests will do so. Fusion deficiency is essentially a neuro-ophthalmological problem. Its importance to education lies in its tendency to impair good two-eyed vision.

Another component of binocular vision is stereopsis or depth perception. This arises from the fusion of two similar pictures sent back to the brain from the eyes. Actually each picture is viewed from a slightly different angle because of the space between the eyes and when the images are fused the difference makes possible the perception of depth. Other factors such as the relative size of objects seen and the tension on the ocular muscles play minor roles in stereopsis, which, like general fusion, may be defective. It is not probable that such defectiveness, per se, could affect school performance except in art courses, some physical education exercises, or sports where misjudgement of distance might appear. From time to time it has been suggested that stereopsis may contribute in some way to reading efficiency. Witty & Kopel[17] reported that it did not differentiate good and poor readers, but Park[18] found that twenty-two percent of his cases of reading difficulty presented extremely weak or absent stereopsis.

How Heterophoria Affects Reading. The eyes must work together as a team if the child is to have efficient binocular vision. They must coordinate easily and efficiently and aim at the same thing so that the picture sent to the brain from one can be combined with that from the other, resulting

---

[16] Lancaster, J. E., *A Manual of Orthoptics*, Springfield, Ill., C. C. Thomas, 1951, pp. 77 and 48.

[17] Witty, P., and Kopel, D., "Factors Associated with the Etiology of Reading Disability." *Journal of Educational Research, 29*, February 1936, pp. 449–459.

[18] Park, G. E., "Reading Difficulty from the Ophthalmic Point of View." *American Journal of Ophthalmology, 31*, January 1948, pp. 28–34.

in single vision with the two eyes working at once. This means that the six muscles which move the eyes must work in harmony. Eyes that coordinate well without any tendency to deviate are said to be orthophoric. Sometimes, due to neuromuscular and fusional weaknesses, the eyes are able to coordinate only with a more than normal effort. When this happens there is a *tendency* for the eyes to deviate; to overconverge, diverge (underconverge) or for one to turn above the other. The tendency is kept in check most of the time by the extra muscular effort required but temporary double vision is potentially present and may occur momentarily. This predisposes to fatigue, disinterest in book and desk work, and confusions and loss of place in reading.

Among recent investigations that of Park[19] showed heterophoria in forty-five percent of his group of reading difficulty cases, while Robinson[20] reported "Binocular incoordination of significance" in forty-eight percent of her poor readers. The present author found heterophoria in distant vision among eight percent of his cases of reading difficulty, while thirty-seven percent displayed heterophoria when tested at the reading distance. His unselected cases presented twelve percent *more* heterophoria in distant vision and nine percent *less* at the reading distance. Park[21] considered lateral heterophorias present only when they were of four prism degrees or more, and vertical heterophorias when they were of two or more degrees. I have considered lateral heterophorias present when they were of six or more prism diopters, and vertical heterophorias when they were of one or more prism diopters. Robinson did not specify the limits of measurement but her cases like those of Park and myself, were examined by ophthalmologists and probably somewhat similar limits were used.

Heterophoric pairs of eyes that *tend* to overconverge are called esophoric, those which *tend* to converge insufficiently or to diverge, exophoric, and those that *tend* to deviate vertically hyperphoric. There are other variations and types of heterophoria but these are the principal ones.

Esophoria (*tendency to overconverge*) is an important handicap to learning when it occurs in considerable degrees but it is not of significantly greater frequency among groups of passing and failing pupils. It is even possible that a slight amount of it might make it a little easier for the child to hold fixation on his book or desk but this is speculation and has not been proven. The author has found a somewhat lower incidence of esophoria in both distance and near vision among reading failures as compared with unselected children. This supports the foregoing supposition to some extent. Scobee[22] has pointed out that esophoric children do poorly in such games as baseball, tennis, and badminton.

Hyperphoria (*tendency to vertical deviation*) occurs about as frequently among failures and non-failures but when it is present it often handicaps the student in coping with his studies. Such was the case of an Ed.D. candidate who had almost constant headache and who found that after reading for fifteen minutes he could not keep his place but jumped to the line below. This interfered with meaning and he was constantly stopping and hunting for his place, only to have the same thing happen again a line

[19] Park, G. E., Op. Cit.

[20] Robinson, H. M., *Why Pupils Fail in Reading*, University of Chicago Press, Chicago, 1946.

[21] Park, G. E., Op. Cit.

[22] Scobee, R. G., *The Oculorotary Muscles*, C. V. Mosby Co., St. Louis, 1947, p. 130.

or two below. When his hyperphoria was found and corrected by prismatic glasses he was able to read efficiently for long periods and completed his doctorate work without further trouble from his eyes.

Hyperphoria sometimes causes confusions and loss of place in reading but its most important effect lies in the tendency for the reader to shift his fixation to the line above or below the one on which he is trying to read. The hyperphoric child often finds he can read easier with either eye alone and is sometimes seen to shut or cover one eye when reading.

Exophoria at the Reading Distance (*tendency to insufficient convergence*) occurs more frequently among reading failures than any other type of heterophoria. While low degrees of it are sometimes considered physiological, medium to high degrees predispose to confusions, omissions, regressions, loss of place and their consequent impairment of meaning. Its significance in reading has been pointed out by Eames[23] and Park.[24] The pupil attempts to compensate for it, overexerts his eye muscles and tires rapidly.[25] This type of heterophoria appeared in significant degree (6 prism diopters or more) in about a third of the author's reading failure group but in only about a fifth of his unselected school pupils.

There are no clear-cut symptoms or signs by which a teacher may suspect the presence of heterophoria among her pupils. Discomfort during reading or desk work, poor concentration, blurring of print, ability to read easier with either eye alone, line shifts, and even occasional double vision may suggest heterophoria but they can also result from other eye handicaps. When reading, an occasional child with a severe heterophoric handicap will pause, open his eyes widely, peer at the book, and then go on reading or reread the whole sentence. When heterophoria is suspected, short reading and writing assignments and practice periods should be permitted until the child has visited the eye doctor.

Strabismus (*eyes not straight*). Strabismus is an *actual deviation* of one or both eyes, up, down, in, out, or oblique. Sometimes the deviation in one eye is of a different type and degree from that of the other. Although the common name for all types is "cock-eyedness" children often differentiate the types. A child with external or divergent strabismus may be called "wall-eyed," one with internal or convergent strabismus "cross-eyed," while the name "cock-eyed" may be reserved by some for those with vertical or oblique deviations.

Strabismus is fairly common among school children and draws jibes from classmates. Its effect on reading, except in the first few weeks after onset, is likely to be less of a handicap than heterophoria since many children tend to suppress the vision of the deviating eye or one eye of a deviating pair and become one-eyed readers. Vision in the suppressed eye is little used and gradually regresses (amblyopia ex anopsia).

A happier situation exists when the child involuntarily fixates first with one eye and then the other, using each alternately. This tends to prevent loss of vision from non-use.

There is an accommodative type of strabismus frequently seen in the classroom and due to hypermetropia of rather considerable degree. The

[23] Eames, T. H., Op. Cit., *Comparison of Eye Conditions, etc., No. 8.*

[24] Park, G. E., Op. Cit.

[25] Eames, T. H., "A Frequency Study of Physical Handicaps in Reading Disability and Unselected Groups," *Journal of Educational Research, 29*, September 1935.

child comes to school with straight eyes but as he tires one gradually turns in and by the close of school a marked deviation is apparent. Ordinarily this condition, unlike other forms of strabismus yields fairly well to glasses which correct the hypermetropia.

Strabismus persists over a long period and the outlook depends on the cause. Its presence is readily detected by both parents and teachers because the turning of the eye is obvious to both.

Comparatively few studies of the effect of strabismus on reading or among reading failures have been made but various investigators have expressed the opinion that the child with poor binocular vision is handicapped in his school work.[26, 27] On the other hand, when strabismus is acquired during the school years distractions arising from double vision and errors comparable in a general way to those discussed under heterophoria may occur during the first few weeks until the pupil has learned either to use one eye at a time or to suppress the image of the eye which turns.

Doctors commonly refer to strabismus as "squint" while teachers use the same word to describe the frowning that accompanies an extreme effort to see. In general, the strabismic (or squinting) child tends to be high strung and over-sensitive. He often feels different, inferior, and left out so he develops a defense reaction, becoming either shy and introverted or over-aggressive and extremely extroverted.

The teacher should report deviating eyes to the parents or proper school authorities when she observes them.

Strabismus is treated in a great many ways but probably most often by surgery, sometimes, but not always, with adjunctive orthoptic exercises and glasses.

Relationship of the Field of Vision, Eye Span, and Reading

Research findings suggest a probable relationship between the span of visual perception and the extent of the visual field. This can be thought of as a charting of that area of retina which responds to light sufficiently to give rise to vision. Each eye has its own (monocular) visual field and sometimes one speaks of the combined or fused fields as the binocular field.

The central part of the visual field is what concerns us in reading. The normal central field is generally regarded as extending nasally 26 degrees, temporally 33 degrees, upward 26 degrees, and downward 28 degrees when tested on a tangent screen at 750 mm. distance and with a 1 mm. white test object.[28] In the center of this field is represented the point of fixation, corresponding to the fovea (small area in macula lutea, or yellow spot of the retina) where only one type of receptor cell (cone) is found. Destruction of this area results in loss of central vision. When a pupil makes a fixation in reading he moves his eyes so that the image of the object or symbol falls on the fovea, where visual acuity is at the maximum. The sensitivity of the retina diminishes from this point outward to the periphery. The fovea is so small that it is capable of reacting to only about 3/10 of an inch of line or column.

[26] Betts, E. A., *Prevention and Correction of Reading Difficulties*, Row, Peterson & Co., Evanston, 1936.

[27] Stromberg, A. E., "Psychology of the Squinter," *American Journal of Ophthalmology*, *30*, May 1947, pp. 601–606.

[28] Berens and Zuckerman, Op. Cit., p. 377.

If only the fovea were involved in reading it would be necessary for the individual to make many more fixations than most do in order to bring the image of the line onto this area, bit by bit. Evidently the immediate extrafoveal retina must participate with the fovea in perception during each fixation and the visual perception span is probably determined in part by the response of the retinal area around the fovea. Limitations of the visual field may restrict the span of visual perception. Sometimes there are restrictions of one field only, sometimes of both, occasionally both are symmetrically restricted and at times one finds them limited in different diameters. These restrictions result from diseases, defects, injuries and hysteria. The hysteric field is concentrically contracted to a small area around the fovea.[29, 30] This is sometimes called a "tubular field." It is variable and narrows down at time of stress. Other types of restriction are often less regular.

Hinshelwood[31] first noted field restriction in reading difficulty. He found a hemianopsia (half of the field blind) and naturally attributed it to neurological causes. Later Hincks[32] noted limitation of peripheral vision, but not enough to be classified as hemianopsia, and speculated that it might have some relation to visual span and could, perhaps, account for perception by small units.

Situated 15 degrees to the nasal side of the fovea is a small area that is normally blind. This is the head of the optic nerve where it enters the eye and, in the visual field charting, one finds a corresponding non-responsive area. This is known as the physiological blind spot. Brombach[33] studied these in poor readers and concluded that enlargement of the blind spot bore some relation to reading difficulties. Kerr[34] also studied blind spot variations and suggested that areas around the physiological blind spot which were not responsive be called "non-receptive areas" and she considered them as a condition of immaturity. Berens and Zuckerman[35] point out an area of relative amblyopia about 1 degree in width which surrounds the blind spot which is probably the enlargement noted by Brombach and referred to by Kerr.

Thus far the studies reported have related to restrictions of the visual field either peripherally or by enlargement of the physiological blind spot. The author's experiments have demonstrated peripheral restriction of greater degree among educational failure cases[36] which supports the idea that there may be some relation between restriction of the visual field and school difficulties. He has been unable to demonstrate any actual enlargement of the blind spot except in pathological cases. Robinson[37] found no

[29] Eames, T. H., "A Study of Tubular and Spiral Central Fields in Hysteria," *American Journal of Ophthalmology, 30,* May 1947.

[30] Yasuna, E. R., "Hysterical Amblyopia in Children and Young Adults," *Archives of Ophthalmology, 45,* January 1951, pp. 70–76.

[31] Hinshelwood, J., *Congenital Word Blindness*, London, H. K. Lewis, Ltd., 1917.

[32] Hincks, E. M., "Disability in Reading; and Its Relation to Personality," *Harvard Monographs in Education, 7,* Harvard University Press, Cambridge, 1936.

[33] Brombach, T. A., *Blind Spot Measurements and Remedial Reading Problems*, American Optical Co., Southbridge, Massachusetts, 1937.

[34] Kerr, Clare, "Learning to See; An Educational Problem," *Los Angeles School Journal, 30,* May 12, 1947.

[35] Berens and Zuckerman, Op. Cit., p. 378.

[36] Eames, T. H., "Restrictions of the Visual Field as Handicaps to Learning," *Journal of Educational Research, 29,* February 1936.

[37] Robinson, H. M., Op. Cit., p. 223.

restricted fields in her thirty cases studied comprehensively. Perhaps the small number of cases accounts for absence of this condition in the group.

A relationship between eye span and the horizontal extent of the visual field is probable. The author has found a correlation of .68, ±.05, between the horizontal measurement and the speed of word perception.

Speed of Perception

Reading is a psycho-physical process involving visual stimulation, followed by transmission of neural impulses to the brain. Cerebral acts follow which result in conscious perception of the words as objects and as symbols. All neural acts are time consuming and there are individual differences in the speed with which the act is performed. Those who are slow in their responses to tests of the speed of object and word perception are often slow in phrase and sentence reading. When reading is slow the child frequently observes that he is lagging behind, hurries, and loses the thread of meaning.

Reading failures as a group present slower speed of word perception and the speed is even slower in the group of reading failures with eye difficulties.

The speed of perception is not always the same for both objects and words, since the latter involve the skill of symbolization, which implies a more complex neurological act. Restrictions of the central field of vision, certain endocrine disorders, eye, nerve, and cerebral defects often predispose to a slow speed of perception for all objects including words, since the latter must first be perceived as objects before their symbolic meaning can become apparent. The child must know he is looking at a word before he can understand its meaning.

Excessive phonetic training which emphasizes the parts of words rather than their meaning, emotional blocks associated with past reading failure, and inadequate sight vocabulary for the grade are associated with slow word perception without necessarily involving object perception. There is some question as to whether inadequate sight vocabulary causes or is caused by slow speed of word perception in such cases although the distinction is fairly clear in the presence of slowness in both object and word recognition.

When the speed of perception for both objects and words is retarded the probable cause is a physical one, such as eye defect or endocrine dysfunction. When the speed for objects is normal and that of words is slow the probable source of difficulty is usually to be found in the educational area. These pupils are the ones who respond best to short exposure drill with flash cards, tachistoscopes, etc. Their speed of word perception can often be brought into line with that of objects. Those with a higher speed of word perception than speed for objects have usually had too much short exposure drill and, in the experience of the author, have tended to return to the speed level of object perception within a short time after intensive short exposure word practice has been stopped.

Short exposure exercises may be made with a variety of devices such as flash cards and tachistoscopes. Harris[38] gives directions for making a simple one. An excellent tachistoscope is included in the Durrell Analysis of Reading Kit[39] and may be purchased separately. The present author has described a projector type which any camera repair shop can produce

[38] Harris, A. J., *How to Increase Reading Ability*, New York, Longmans Green, 1948, pp. 187–188.

[39] Durrell, D. D., *Durrell Analysis of Reading Difficulty*, World Book Co., New York, 1955.

by a simple addition to the common 2″ x 2″ glass slide projector used for kodachromes.[40, 41] Many short exposure, pacing, and accelerating devices are available commercially.

Short exposure exercises designed to increase the speed of visual perception for objects, words, or both are administered by *both* teachers and the various categories of eye doctors and their assistants. When given by the optical-ophthalmological group they are usually referred to as falling in the field of orthoptic exercises. This author's experience has been that they are best administered in close correlation with the reading lesson, so that learning is more direct and transfer is not as necessary. New and review words can be used as reading progresses. Beyond the point where reading is a separate subject and in the absence of remedial training there is no daily reading lesson with which to tie short exposure drill. When spelling is a separate subject the spelling words may be used in the drill. Otherwise the only precaution is to keep the words proportionate to the achievement level of the pupil.

Lateral Dominance And Reading

Lateral dominance in terms of eyedness and handedness, is often considered a possible cause of reading failure. Dominance itself originates in the brain rather than in the peripheral organs which manifest it. Left manual dominance probably has a strong relationship to the production of mirror script in some cases and appears to be related to speech variations, but to what extent this entity may cause reading failure is debatable. It is probable that combinations of eyedness and handedness other than right-eyedness with right-handedness may be related to poorer than average performance in learning to read and may be one of the causes of reversals of words, mirror writing, and possibly mirror reading. Probably the commonest and presumably the most troublesome of these variations is left-eyedness with right-handedness, a form of crossed dominance. This has occurred more frequently than any other variation among both reading failures and unselected groups in this author's investigations and has been approximately ten percent more frequent among his reading failures.

Various attempts to improve the capacity for learning to read by changing either or both eyedness and handedness have been made. They have ranged from wearing a mitten on the undesired dominant hand and covering the undesired dominant eye to tieing the undesired hand behind the back and overcorrecting or occluding the undesired eye by means of lenses. This author's observation has been that such attempts usually have caused more distraction than benefit and have not been related to improved reading capacity. Some cases have shown a tendency to develop speech hesitations when dominance has been interfered with in the presence of reading difficulty. This is not invariably true. Speech correctionists often change dominance practices with reportedly good results on speech.

Lateral dominance concepts have been enlarged recently through a distinction between the dominant eye and the controlling eye.[42] When one

[40] Eames, T. H., "A Study of the Speed of Word Recognition," *Journal of Educational Research, 31*, November 1937, pp. 181–186.

[41] Eames, T. H., "The Speed of Picture Recognition and the Speed of Word Recognition in Cases of Reading Difficulty," *American Journal of Ophthalmology, 21*, December 1938, pp. 1370–1375.

[42] Berner, G. E., and Berner, D. E., "Relation of Ocular Dominance, Handedness and the Controlling Eye in Binocular Vision." *Archives of Ophthalmology, 50*, November 1953, pp. 603–608.

eye is dominant and the other controls perception in binocular vision the child is deemed likely to have trouble with speech, reading, and writing. Training has been directed to changing the controlling eye to the opposite side but its effectiveness has yet to be determined. The concept is interesting and may hold promise.

Teachers should not attempt to change the eyedness, eye control or handedness of their pupils but rather to emphasize the left to right approach to reading, writing, and spelling. More than the average amount of drill should be given on reversible words and commonly reversed parts of words. The child may be allowed to use a guiding finger under the line he is reading to reenforce the left to right progression through the sentences. This should be eliminated as soon as reasonable freedom from reversals has been attained.

The Blind or Partially Seeing Child in School

The child with visual or eye defects of moderate degree or one who has reasonably good vision when wearing glasses may remain in regular classes but the "partially seeing" and the "blind" require special educational attention. The partially seeing have been discussed in the section on low vision and amblyopia. Children with visual acuity between 20/70 and 20/200 in the better eye or those with general or local illnesses that affect sight seriously are considered to be in this group. They need sight-saving class placement.

These classes are not the same as "special classes" or "opportunity classes." They operate as nearly like other classes as possible with the exception that the physical characteristics of the room, its furniture and the instructional materials, are adapted to children with poor vision. Pupils with other physical defects have no place in sight-saving class unless their greatest problem is poor seeing. Teachers in such classes are specially trained and know something of the visual problems of their students, the physiology of vision, eye defects and diseases and the adaptation of instruction to the capabilities of the visually handicapped. There are comparatively few children who require sight-saving class placement.

Many small towns have no pupils of this type. Most large cities have a number of them. Probably about one child in five hundred should be in a sight-saving class. Many of the larger school systems have one or more such classes which are maintained by the local school department with state aid. When there are sufficient cases in less thickly populated areas a class is often established in a central location and transportation is provided for the pupils who attend it. Under such circumstances it is usual to include a number of grades in one room as was the case in the "Little Red Schoolhouse." The number of pupils admitted is determined by local conditions but an optimum number is in the neighborhood of 15 to 20.

The curriculum is as nearly like that of regular classes as is possible, but the texts are printed in large type on unglazed or matte surface paper, typewriters, especially with large type, are available to pupils and teachers and special instructional materials, such as charts, maps, etc., are provided.

Attention should be given particularly to provision of adequate illumination. Both artificial and natural lighting should be readily controlled, properly directed and distributed and glare-free. Open tubes or bulbs should not be used without diffusers and all factors in the illumination should be held to the highest standard of excellence. Furniture should pro-

vide adjustments whereby the optimum seeing distance for the individual can be met. Some sections require sight-saving classes but are unable to provide them. In such cases a local or county supervisor should fit herself for such work by taking courses in the field at a teachers college or school of education and then put into practice as much as local conditions will permit.

The blind child differs from the partially seeing in being unable to see well enough to profit by sight-saving class instruction. Not all blind children are really sightless as is commonly supposed. Many have vision of some degree ranging from total absence of sight to about 20/200. Many borderline cases are to be found in sight-saving classes and even in regular classes but the work is very difficult and some of it is impossible for them. Often *educationally blind* children can see enough to run and play out-of-doors whereas the totally blind individual cannot do so except in very familiar surroundings.

The blind child (in the physiological rather than the educational sense) depends on other sensory impressions from his environment. He knows things by their feeling, shape, texture, sound, odor, taste, condition of heat or cold, etc. He is disinterested in hearing about things that he has never experienced because he has no concept of them. For example, description of a beautiful sunset or color combinations among flowers, clothing, or other things leaves him cold. Color, like light, is an abstraction as far as he is concerned. His habits of thought and behavior are conditioned by his sightlessness.

He is not the pitiable creature that seeing people imagine him. Never having seen he knows nothing of sight and does not miss it. One boy the author saw became able to see late in childhood but preferred to play with his eyes closed tightly since seeing, for him, was a disagreeable, distracting experience. Many blind children also present other physical deficiencies, of which speech defectiveness is common. Since they are sedentary and have fewer experiences to describe they have less inclination to talk and to make use of speech to the extent that other children do.

Blind children are not deprived of education or literature. They can learn to read with their fingers. Reading takes place in the brain and it is not particularly important by which sensory channel the impulses from the symbols reach it. The seeing child uses visual impulses while the blind child learns to depend on touch. Like the seeing child he has learned sound symbolism in connection with the development of speech and it is only necessary to present him with a set of tactile instead of visual symbols for letters, words, and the meaning that they convey.

Such an alphabet was devised by Louis Braille, consisting of embossed "dots" which the blind child can feel and recognize. These dots are arranged in a Braille cell, consisting of six dot positions in two vertical rows of three. Combinations of dots in these positions provide tactile letters, punctuation marks, and, with special signs, numerals and capital letters. If the dots are too sharply pointed they overstimulate the tactile mechanisms in the fingers and if too broad are difficult to recognize in combinations. The fingers rest on the dots and form an acute angle with the page. The fingertips rest on the upper two rows of dots and with somewhat slighter pressure on the third row. They move along in a gliding motion across the page and enable the reader to recognize the combinations as letter and word symbols. Just as there is a kind of prereading among seeing pupils there is among Braille readers. The seeing reader apprehends

what comes before the actual fixation point by peripheral retinal response. In other words, he sees what is coming out of the corner of his eye. The Braille reader does the same by using a finger of one hand to read and a finger of the other to run along about half a line ahead. Whereas the seeing reader may complain of tired eyes when he has read a long time, the Braille reader experiences fatigue in his reading fingers.

There are two types of Braille reading, Grades I and II. The former spells out each word completely, while the latter employs contractions for frequent letter combinations and words.

Readiness for Braille reading includes the same sort of thing as does visual reading, with the addition of the development of tactile discrimination rather than visual discrimination. Pupils practice differentiating and identifying cubes, cylinders, triangles, spheres, paper clips, and other common objects. Later a large pegboard is used, followed by a smaller one. Then Braille letter shapes are introduced and the child is familiarized with them. He is also taught to follow Braille lines.

Finally the Braille primer is introduced. A tactile vocabulary is built up, including the contractions of Grade II Braille. During the early stages pupils learn to read Braille about as fast as others learn visual reading but as the material becomes more complex the speed falls behind that of seeing children.

Sources

Galisdorfer, Lorraine, "New Learning Materials for Partially Sighted Children," *Journal of Exceptional Children*, *16*, January, 1950, pp. 103–113.

Idem., "A New Annotated Reading Guide for Children with Partial Vision," *The Author*, Charles A. Lindbergh School, Kenmore, New York.

Hittell, M. J., "A Bibliography on Handwork for Teachers of Partially Seeing Children," *Sight-Saving Review*, *17*, Publication 469, National Society for Prevention of Blindness, 1790 Broadway, New York.

N. Y. Board of Education, Department of Child Welfare, *Reading in Sight Conservation Classes*, 110 Livingston Street, Brooklyn, New York.

McLeod, B., *Teachers Problems with Exceptional Children. I. Blind and Partially Seeing Children*, Office of Education, Pamphlet No. 40, 1933, U. S. Government Printing Office, Washington, D. C.

General Inquiry: National Society for the Prevention of Blindness, 1790 Broadway, New York.

Textbooks for Partially Seeing Children

Textbooks for partially seeing children are produced by a number of publishers, including the following, and others:

Allyn & Bacon, 50 Beacon Street, Boston, Massachusetts.

American Printing House for the Blind, 1839 Frankfort Ave., Louisville, Kentucky.

Clear Type Publishing Committee, Pompton Lakes, New Jersey.

Iroquois Publishing Co., Syracuse, New York.

Row, Peterson & Co., White Plains, New York.

Silver Burdett Co., 45 East 17th St., New York, New York.

Stanwix House, 1306 Highland Bldg., Pittsburgh, Pennsylvania.

John C. Winston Co., 1010 Arch St., Philadelphia, Pennsylvania.

Some of the textbooks of the following publishers are available in sight-saving editions.

Ginn & Co., Statler Bldg., Boston, Massachusetts.

Lyons & Carnahan, 225 South Main St., Wilkes-Barre, Pennsylvania.

Scott-Foresman & Co., 623 South Wabash Ave., Chicago, Illinois.

Eye Diseases As Handicaps to the Learning Process

Eye diseases among school children are very much less frequent than eye defects as handicaps to reading. They interfere with school achievement through possible visual impairment and enforced absence. Children with certain eye diseases, such as conjunctivitis, usually are excluded from school until they recover. Others with chronic conditions which produce low vision, such as those with opacities of the lenses in the eyes, require sight-saving class techniques and materials. From the classroom teacher's point of view their problem is that of the amblyopic pupil. Therefore it is necessary to discuss only a few of the common eye diseases to which some special importance is attached. The epidemiological and hygienic aspects of eye disease among children is the proper concern of the ophthalmologists and school hygienists.

The following eye diseases are those most often inquired about by reading teachers.

Cataract is not infrequent among school children, although usually thought of as being a disease of elderly people. Sometimes the opacities which occur in the lens are few and scattered while in other cases the entire lens is opaque and cannot be seen through. There are a great many causes of cataract, including developmental anomalies in the prenatal period, metabolic diseases such as diabetes and hypoparathyroidism, injuries, and other conditions. One of the commonest cataracts among children is the lamellar type,[43] which is particularly likely to follow when the mother has German measles during pregnancy.[44] This interferes with the development of the lens in the eye. Later when nutrition is better, normal layers are laid down over these and the lens appears on superficial examination to be healthy. Cataracts of any type interfere with the child's vision to a greater or lesser extent, depending on the opacities in the lens substance. School children's cataracts are likely to be stationary since the conditions which produce them are often passed before the child enters school. However, some grow worse. As soon as cataract is detected in a pupil he should be referred to an ophthalmologist. Some cataracts which result in little visual impairment may require no treatment but those which interfere seriously with the child's ability to see may require surgery.

Conjunctivitis. The eye disease most commonly encountered among school children is conjunctivitis, usually called pink eye. It is an epidemic, contagious disease, characterized by redness of the eyes, a certain amount of discharge, and a feeling of discomfort. Children often complain that they have sand in their eyes when conjunctivitis is coming on. Older people

[43] Traquair, H. M., Op. Cit., pp. 192–193.

[44] Cordes, F. C., "Cataract Formation in the Human Embryo after Rubella," *Archives of Ophthalmology*, *42*, November 1949, pp. 596–605.

commonly go to an ophthalmologist thinking that they have some foreign body in the eyes. Most schools exclude pupils with conjunctivitis until readmitted by the school physician after recovery. The enforced absence from classes is the only real handicap to learning that usually results. If the child with conjunctivitis remained in school he would find reading and desk work uncomfortable. He would probably share his pink eye with many of his classmates and perhaps his teacher.

Syphilis. Congenital syphilis often causes a serious eye condition known as interstitial keratitis. It is not the only cause but is a very frequent and important one. The syphilitic form usually appears during school ages but is rare under the age of three. The child's eyes are red and dull, they water, and the individual complains that light hurts them. During the onset of the illness a teacher might confuse it with pink eye. Vision falls as the disease advances. Between eight and ten percent of the cases are left with vision below 20/200 which is a serious visual handicap. Others improve to a variable extent, a few regaining normal sight. The severity of the disease results in absence for at least two months, and home assignments are not advisable. Throughout the greater part of the period book and desk work is practically impossible.

Corneal Scarring. Scarring of the cornea which results from ophthalmia neonatorum, a disease common in early infancy, produces a reduction in visual acuity and constitutes a handicap to learning which persists through the school years. Much blindness resulted from this disease in times past but it is being rapidly overcome by prophylactic measures at birth for all children. Both cataract and corneal scarring can be treated surgically with fair to good prospects of improvement in vision.

Styes. Styes (Hordeola) and blepharitis (inflammation of the margins of the lids) produce discomfort which distracts the pupil. Iritis and other deep inflammatory processes also interfere in a similar way but the educational importance of all of them is primarily absence from class since most persons with the more serious eye inflammations are usually unable to remain in school more than a day or two.

Nystagmus. Teachers often ask what can be done for the child whose eyes oscillate rhythmically and do so most of the time. This condition is called nystagmus. Most pupils who exhibit it appear to get along without too much difficulty. It is often congenital. Sometimes, and perhaps more frequently among older students and adults, it results from trouble in the labyrinth or the central nervous system. All cases of nystagmus should be brought to the attention of parents or the appropriate medical authority but there is little else the teacher can do except to favor the child in any tasks that appear to be hard for him to see. Even with adequate medical attention a good many cases will persist and both teacher and pupil will have to learn to live with the condition as it is.

Retrobulbar Neuritis. A condition which produces sudden blindness or partial blindness among upper-grade and college students is retrobulbar neuritis. It is an inflammation of the part of the optic nerve between the eye and brain. About two-thirds of the cases are due to disseminated sclerosis, a nerve disease which may not show itself in any other way until several years after the attack of retrobulbar neuritis.

Blindness in one or both eyes may come on suddenly, sometimes with

headache and soreness of the eye when moved or pressed upon. The author has seen cases in which the student would have good vision when he went to school in the morning but would find his sight impaired very badly before coming home in the afternoon. A few have lost vision completely during the school day. Such an experience is alarming to the pupil and quite upsetting to his teacher. The blindness may affect one or both eyes and sometimes it comes on in one before affecting the other.

After a period of two weeks or more vision usually improves and often comes back completely to normal. Sometimes other attacks follow. If so they may impair the optic nerve so that vision remains permanently subnormal. If the optic nerve fibres degenerate and the nerve atrophies permanent partial or complete blindness may result but this is not common among people of school age.

The educational handicap in retrobulbar neuritis stems from absence, and in some cases from permanent visual impairment. At the time of the attack there is emotional upset for the child or young adult who suddenly finds himself unable to see. His classmates may be disturbed about it to a variable extent, especially if he is very much upset and shows it. Absence follows *without* the possibility of doing out-of-school work to keep up with the class. Any possible residual dimness of vision following an attack handicaps the learner just as would low vision from any other cause.

When a student suddenly discovers himself blind or visually restricted in either or both eyes he should be sent home in the company of another person. If he is at a boarding school he should be sent at once to the school nurse or physician. All cases of retrobulbar neuritis should be seen by an ophthalmologist and a neurologist; the first to manage the disease itself and the second to discover whether or not disseminated sclerosis is present and if so, to treat it.

When the student returns to school his visual acuity should be tested. If it is still below normal teachers should not expect him to compete fully with normally seeing classmates. Even if it is fully normal he should be helped to avoid difficult seeing tasks for several weeks. When in doubt the teacher should be guided by the opinion of the student's doctors, with whom she may communicate through the parents. If the doctor is at hand he might be asked to express an opinion as to whether or not the pupil is able to assume the usual visual tasks.

Retrolental Fibroplasia. Retrolental fibroplasia was formerly an important cause of blindness among prematurely born children. It has since been found that the high concentrations of oxygen given such infants may have contributed to this disease. Current practices have reduced the incidence of retrolental fibroplasia to such an extent that it is no longer necessary to give it special consideration as a common cause of poor vision that may persist into the school years.

SUMMARY OF A COMPARATIVE STUDY OF EYE CONDITIONS AMONG READING FAILURES AND UNSELECTED PUPILS

Sex. Eighty percent of reading failures were boys and twenty percent girls. Eye defects did *not* influence this sex incidence.

IQ. Forty percent of reading failures having eye handicaps presented IQs under 90. Correction of the handicap resulted in no greater improvement in reading age in the year following correction than in the year before it unless remedial instruction was given. Forty percent of reading failures had eye handicaps and IQs of 90 or more. Their increment in reading age, in the year following correction and without special instruction during that time, was nearly twice as great as in the year before.

Lateral Dominance. Reading failures presented ten percent more left-eyedness with right-handedness and seventeen percent less right-eyedness with right-handedness than did unselected school children. Lateral dominance variations from right-eyedness with right-handedness occurred in fifty-seven percent of reading failures contrasted with forty percent of the unselected.

Premature Birth. Premature birth has been found to be an important handicap. The sex frequency of reading failure was found to be the same as among the non-premature with eighty percent of the cases boys and twenty percent girls. However, reading failure occurred among fifteen percent of the premature cases and only among five percent of the full-term cases. Seventeen percent of the premature cases presented defective vision. There was a higher frequency of low vision at all ages from five through seventeen among them and poorer median visual acuity through the ninth year. Poor vision has been found to persist into the middle grades in an appreciable number. The birth weight, which is the criterion of prematurity, correlates more closely with visual acuity and the speed of object and word perception among the premature. Birth weight, visual acuity, and the speeds of object and word perception also presented higher positive correlations among these children than among the unselected. The premature cases also exhibited twenty percent more lateral dominance variations and fourteen percent more amphiocularity with right-handedness than the full-term pupils. There was a somewhat greater incidence of eye diseases among the premature and an appreciable difference of thirty-one percent more neurological lesions than among the children whose birth weights fell in the normal range above five and a half pounds.

Visual Acuity. There was little difference in the incidence or central tendency of visual acuity among reading failures and unselected school children but there was some correspondence between visual acuity and birth weight among the premature, in whom reading failure was more frequent than among children of normal birth weight. There was also a reasonably high correlation between visual acuity, and the speed of visual perception of objects and words. As explained elsewhere defects of visual acuity as commonly measured are not statistically important since a very large number of children are able to achieve compensation for it but at the expense of fatigue resulting from excessive demands on accommodation.

Refractive Errors. Among the refractive errors, hypermetropia of one diopter or more was thirty percent more frequent among reading failures, occurring in forty-three percent of the cases. Hypermetropic reading

failures in Grades III and IV have presented a greater difference between reading age and chronological age than myopic or emmetropic reading failures. Those with myopia occurred at about the same frequency among the unselected and those who had difficulty in learning to read. The difference between the median reading and chronological ages among the reading failures (Grades III and IV) fell between that of the hypermetropic and emmetropic groups. Astigmatism occurred two percent more frequently among the author's cases. Studies suggest that refractive error is a greater handicap to reading failures than to non-failures, since there is less difference in median reading age and median chronological age (Grades III and IV) in the different refractive error groups. Refractive errors may tend to condition eyedness in some cases since sixty-five percent of anisometropic cases presented eye dominance in the eye with the smaller refractive error. Glasses are used to correct refractive errors but they do not always improve visual acuity and are often not intended to do so. Nineteen percent of children wearing glasses presented the same visual acuity with and without them. This is particularly true of hypermetropic children, among whom twenty-three percent had the same visual acuity whether or not glasses were used. (See discussion in another chapter for reason.) Glasses, particularly weak ones, tended to retard rather than increase the speed of object and word perception at the reading distance among twenty percent of myopic children. The same thing occurred among hypermetropic pupils to the extent of from two to five percent for the speed of object perception and from eight to eleven percent for word perception. Generally use of glasses of three diopter power or over resulted in an increase in the speeds of both object and word perception.

Strabismus. Strabismus, or deviation of one or both eyes from the normal position of parallelism, occurred almost twice as often among reading failures as among the unselected, but the frequency was not high. Although the frequencies of the component types were low, convergent strabismus was the most common and occurred twice as frequently among the reading failures of the various types observed by this investigator.

Muscular Imbalance. Muscular imbalance, on the other hand, showed a variation with the type of defect. Reading failures exhibited eleven percent more exophoria of 6 prism diopters or more *at the reading distance* than did the unselected, but esophoria of a like amount *at the reading distance* occurred two percent less often. Hyperphoria was of infrequent occurrence in either reading failure or unselected groups with a very slightly greater incidence among the poor readers. A third of the reading failures had exophoria of 6 or more prism diopters at the reading distance.

Fusion Deficiency. Fusion deficiency occurred in twenty-two percent of reading failures, which was four percent more than among the unselected. Early studies on smaller groups showed a much greater difference of the same kind, ranging as high as twenty-eight percent more among the reading failures.

Perception of Objects and Words. The speed of word perception has been found to be retarded in forty-nine percent of reading failures and twenty-five percent of the unselected, a difference of twenty-four percent. The median speed of word perception among the poor readers was three times slower than among the unselected. Early studies also showed a similar difference in the incidence of retarded speed of perception of objects

(pictures) but at present the indications are that the difference between reading failure and unselected groups in their speed of object perception is too small to be significant.

Correlations between the horizontal diameter of the central field and the speeds of object and word perceptions were 65 and 68 (both plus or minus 0.05) respectively. When the median speeds of object and word perception were determined by age level it was found that the speed of word perception fell off sharply among both reading failure and unselected groups at year X. However, the unselected recovered within the following year, while the reading failure median did not reach comparable levels again for three years. This is believed to be related to the change from dependent reading to practical use of texts or the change from reading as a separate subject to reading as a tool in other subjects. The endocrine part of the study of physical handicaps to learning shows that hypothyroidism retards the speeds of both object and word perception.

Fields. An early study showed that reading failures have smaller central visual fields than the unselected. After treating the underlying causes of field restriction, a small number of cases were rechecked. Seventy percent showed a larger horizontal diameter of the visual field, and all of them presented higher speeds of both object and word perception. More recent studies have shown that central field restrictions vary directly with the speed of perception for objects and words and the horizontal measurements of the diameter of the central visual field correlate positively with the speeds of object and word perception as stated in the paragraph on the speed of perception. Hysteria among reading failures is fairly common and both tubular and spiral central fields are seen in such cases. Nine percent of unselected school children exhibited such fields in one component study and forty-four percent of them also had amblyopia of a moderate degree. Eleven percent had amblyopia of a rather considerable amount.

Eye Diseases. Pathological eye conditions as distinguished from eye defects and deficiencies have appeared to the extent of nearly five percent among reading failures which is slightly less than twice the frequency found among the non-failures. The frequencies of the separate illnesses in reading failure, non-failure, and unselected groups are all low and thus far have been treated as a single composite group. One study showed retinitis and atrophy of the optic nerve, each occurring in four percent of reading failures.

Visual Motor Gestalten. Study of fifty cases of reading failures disclosed certain visual motor reactions associated with amblyopia and with lateral dominance variations from right-eyedness and right-handedness. Amblyopia appeared to have as fairly frequent concomitants such manifestations in the test as fragmentation, simplification, and coordination difficulty, while the lateral dominance variants exhibited considerable coordination difficulty, the production of large, scrawling copy, and either simplification or elaboration. It was suggested that the eye condition may have influenced the visual motor performance.

Eye Conditions of Reading Failures with Brain Damage. Recent comparison of reading failure and non-failure groups of children with brain damage has shown that the poor readers whose brain damage stemmed from *external force* exhibited significantly higher frequencies of aphasia, amblyopia, and fusion deficiency than those whose reading was progressing

in a satisfactory way. Reading failures with brain damage due to *disease* presented rather markedly higher frequencies of muscular imbalance at the reading distance, strabismus, and retarded speed of perception.

Selected Bibliography of Previous Reports
By Thomas H. Eames

"Comparison of the Ocular Characteristics of Unselected and Reading Disability Groups," *Journal of Educational Research*, *25*, March 1932, pp. 211–215.

"The Anatomical Basis of Lateral Dominance Anomalies," *American Journal of Orthopsychiatry*, *IV*, October 1934, pp. 524–528.

"Frequency Study of Physical Handicaps in Reading Disability and Unselected Groups," *Journal of Educational Research*, *29*, September 1935, pp. 1–5.

"Restrictions of the Visual Field as Handicaps to Learning," *Journal of Educational Research*, *19*, February 1936, pp. 460–465.

"A Study of the Speed of Word Recognition," *Journal of Educational Research*, *31*, November 1937, pp. 181–186.

"The Ocular Conditions of 350 Poor Readers," *Journal of Educational Research*, *32*, September 1938, pp. 10–16.

"The Speed of Picture Recognition and the Speed of Word Recognition in Cases of Reading Difficulty," *American Journal of Ophthalmology*, *21*, December 1938, pp. 1370–1375.

"A Study of the Incidence of Eye Defects and Sex among Poor Readers," *Journal of Educational Research*, *33*, October 1939, pp. 102–104.

"Effect of Correction of Refractive Errors on the Distant and Near Vision of School Children," *Journal of Educational Research*, *37*, September 1943.

"Eye Conditions among Children of Premature, Full Term and Hypermature Birth," *American Journal of Ophthalmology*, 29, January 1946, pp. 57–63.

"The Speed of Object Recognition and of Word Recognition in Groups of Passing and Failing Pupils," *Journal of Educational Psychology*, *38*, February 1947, pp. 119–122.

"A Study of Tubular and Spiral Central Fields in Hysteria," *American Journal of Ophthalmology*, *30*, May 1947.

"Incidence of Diseases among Reading Failures and Non-Failures," *Journal of Pediatrics*, *33*, November 1948, pp. 1–4.

"Comparison of Eye Conditions among 1000 Reading Failures, 500 Ophthalmic Patients and 150 Unselected Children," *American Journal of Ophthalmology*, *31*, June 1948, pp. 713–717.

"The Effect of Glasses for the Correction of Hypermetropia and Myopia on the Speed of Visual Perception of Objects and Words," *Journal of Educational Psychology*, *42*, March 1949, pp. 534–540.

"Correspondence between Visual Acuity, Refractive Error and the Speed of Visual Perception," *British Journal of Ophthalmology*, *37*, 1953, pp. 312–313.

"Eye and Other Handicaps," *American Journal of Ophthalmology*, *36*, January 1953.

"Correlation between Birth Weight and Visual Acuity," *American Journal of Ophthalmology*, *38*, December 1954.

"The Relationship of Birth Weight, the Speeds of Object and Word Perception and Visual Acuity," *Journal of Pediatrics*, *47*, November 1955, pp. 603–606.

"The Influence of Hypermetropia and Myopia on Reading Achievement," *American Journal of Ophthalmology*, *39*, March 1955, pp. 375–377.

"The Relationship of the Central Visual Field to the Speed of Visual Perception," *American Journal of Ophthalmology*, *43*, February 1957, pp. 279–280.

"Frequency of Cerebral Lateral Dominance Variations among School Children of Premature and Full Term Birth," *Journal of Pediatrics*, *51*, September 1957, pp. 300–302.

"Reading Failures and Non-Failures in Children with Brain Damage," *American Journal of Ophthalmology*, *47*, January, 1959, pp. 74–77.

"De la Rapidez en Reconocer Objetos y Palabras Reflejadas en Pantallas a Grupos de Alumnos Aprobados y no Aprobados." *Optometra* (Habana), IV, Marzo de 1949, 19–24.

"Correlacion Entre el Peso Desde el Nacimiento y la Agudeza Visual, Desde los Cinco Años a los Doce." *Revista de Psicologia* (Madrid), 10, 1955, 497.

"Eye Conditions in Hypothyroidism." *American Journal of Optometry and Archives of American Academy of Optometry*, *35*, August, 1958, pp. 425–427.

CLASSROOM HELP FOR THE CHILD WITH EYE DIFFICULTIES

The teacher can make it easier or harder for the pupil with eye difficulties according to the degree of her observance of a few simple precautions. The following suggestions are applicable to any pupil or group of pupils with eye difficulties of any kind but more particularly those with an actual defect of vision. Her aim is to avoid conditions likely to cause difficulty or discomfort in performing school tasks and to keep classroom and study visual requirements within the capacity of the pupil.

Avoid Glaring Surfaces in the Classroom. These include highly varnished or glass-topped desks and tables, glass-covered pictures, shiny chalk boards, and texts printed on highly reflective, shiny surface paper. Bear in mind that light from windows or lamps reflects from such surfaces at an angle equal to that at which it strikes. This carries it into the eyes of some of the pupils and causes more than average fatigue as well as annoyance. Go about the classroom, try the different seats at different times of day. Lower your head until your eyes are at the same level as those of the pupils. You will find some positions where intolerable glare reflects into your eyes from furniture or chalk boards. Open a book printed on shiny, smooth surface paper and observe that in certain positions there is an irritating highlight running down the convexity of one page or the other. This is sometimes more marked toward the two ends of the book than in the middle. You will also find certain positions at various times of day when reflected light blots out what is written on the chalkboard. When these positions and times are known the child affected may be given activities that will take him out of the unfavorable situation when it exists.

Textbooks should be printed on flat finish paper rather than on highly reflective coated stock.

Do Not Stand in Front of the Windows while Teaching. The contrast between the bright out-of-doors, especially the sky, and the relatively low illumination indoors is so great that you appear as a silhouette when you stand in front of the window. The children cannot see your face clearly, especially if they have eye difficulties. Many of them cannot adjust to both the high and low illumination intensities at the same time and the attempt leads to rapid fatigue and poorer seeing. This is even more marked among albinos and children with cataract, which, by the way, is not exclusively a disease of the elderly. Stand or sit so that the light from the windows illuminates you and your face.

Keep Electric Bulbs and Tubes Shaded so that the light will not shine into the pupils' eyes. Do not seat them facing strong light, either natural or artificial. Doing so invites fatigue, poor seeing, and poor achievement.

Position of Light Source. Windows or lamps should be so placed that light will come over the left shoulder of right-handed pupils and over the right shoulder of left-handed pupils. This permits it to illuminate the child's work and cuts hand shadow down to a minimum in writing. When the light comes from the wrong side the shadow of the writing hand covers the point at which the words are being formed. Some teachers having movable desk and chair units have arranged one row for left-handed children facing the back of the room, when windows are in the left wall. General improvement in the achievements of such pupils have been found in experimental studies by some of this author's graduate students.

Use Large Size Materials. Teachers should use large letters on the board and write them on or just above the level of the child's eyes. Heavily printed charts, maps, and other aids usually termed sight-saving materials are recommended. Heavy dark crayons are preferable to pencils and, if necessary for the amblyopic, large sheets of paper can be used. Texts especially designed for sight-saving use are desirable. A list of the publishers of such texts, including special editions of some of the standard readers, appears in another section. A typewriter with large type is useful in a classroom for children with eye difficulties. Reading lessons can be prepared on it and any other work for the children can be transcribed into large type. Some children with low vision find it easier to write on such a typewriter than to write by hand.

Seating. Albinos and children with vitamin A deficiencies, manifest by light sensitiveness, do best *away* from the windows in a more subdued illumination. Those with astigmatism and cataract may see better in the same location but some of them will see better in stronger light, depending on the nature and extent of their condition. Pupils with amblyopia generally prefer seats next to the windows.

Rest Periods. Rest periods are important for children with eye difficulties, particularly those with hypermetropia. Alternate periods of book and desk work with board work, discussion or other activities not requiring accommodation and discriminating seeing at close distances. Generally it is best to use more board work and less seat work.

Activity Programs can be used in which the good seers can be teamed with those who see poorly or with difficulty, the close, detailed work being done by the former and the less demanding visual task by the latter, thus involving both in a cooperative effort.

Color Blind Pupils, whether fully or partly so, are handicapped in the use of work books and texts involving directions for coloring or employing type of different colors to emphasize parts of words or important sentences. The partly color blind are difficult to detect since they report some colors correctly and confuse others. Do not expect children with color blindness to understand blackboard diagrams and texts produced with different colored chalks and avoid the use of texts involving colored printing. Use black and white materials with such children and make sure that there is good, strong contrast between the black of the words and the white of the page.

Pupils with Lateral Dominance Variations. Do not attempt to change eyedness or eye control except as directed by a specialist. Employ the usual pedagogic techniques directed against reversals. This subject is treated at somewhat greater length in the section on discussion of eye handicaps to reading.

EYE SCREENING TEST

Until quite recently the Snellen visual acuity test was the most widely used instrument among teachers for screening out children with eye difficulties. It is still very extensively used notwithstanding several more adequate tests now available such as the Keystone Visual Survey, the Massachusetts Vision Test, and the Eames Eye Test. The Snellen test detects *only* such eye conditions as reduce visual acuity. It fails to detect hypermetropia when the child is able to compensate with his accommodation, even at the expense of strain. It gives no indication of the state of vision at book and desk distances since it measures visual acuity for distant vision. It does not detect any of the heterophorias or fusion deficiency. Many authors in the field of reading, including the present one, have remarked on its inadequacy, especially for use in cases of reading failure, where some of the troublesome eye handicaps fall in the categories not covered by this test.

Because of the inefficiency of the Snellen test, which at the time was the only one widely used in psycho-educational clinics and schools, this author developed a more discriminating one as a part of his reading research.[1] The test was originally made to provide better eye-screening facilities for the clinicians of the Boston University Reading Clinic. Although intended specifically for use by persons involved in diagnostic reading work it has served many communities as a general screening test. It consists of a battery of five tests, failure on any one of which constitutes failure of the entire test and warrants referral for professional eye examination. The subtests are all adaptations of conventional tests used daily by most ophthalmologists and optometrists.

Test 1 is a Snellen test which is intended to detect conditions that reduce visual acuity in distant vision. The inclusion of the Snellen test as a part of the battery fulfills the specification in some schools that a Snellen test must be used.

Test 2 is a lens test which is meant to detect important degrees of hypermetropia. For general screening the lens supplied with the kit is usually preferred since it detects degrees of defect likely to require glasses. However, reading clinicians often prefer a different one that will give indications of lower degrees of hypermetropia which may interfere with reading without causing much general eye discomfort or other manifestation. A plus 0.75 convex sphere is recommended for this use. Such a lens can be secured inexpensively from any reputable optometrist or optician.

Test 3 is a test of visual acuity at book distance.

Test 4 is a test for heterophoria.

Test 5 is for the detection of fusion deficiency.

A kit of materials for the Eames Eye Test,[2, 3] together with manual and individual and class record forms is available from the World Book Company at a cost of approximately $6.00.

[1] Eames, T. H., "A New Approach to Testing the Eyes of School Children," *American Journal of Ophthalmology, 24*, October 1941, pp. 1170–1173.

[2] Eames, T. H., "The Reliability and Validity of the Eames Eye Test," *Journal of Educational Research, 33*, March 1940, pp. 524–527.

[3] Eames, T. H., *The Eames Eye Test, Revised*, World Book Co., Yonkers, New York, 1950.

When a Child Fails a School Eye-Vision Screening Test. When a child fails to pass the eye-screening test[4] the teacher notifies the parents on the appropriate form provided for the purpose in her school system. The parental reaction to this notice is quite varied. Some parents comply with the request that the child be taken to their eye doctor. Many of them appreciate the school's solicitude for the welfare of their children. Other parents are irked at first but think it over and finally do as the notice requests, often grumblingly. Some parents cannot accept the implication that *their* child is not absolutely perfect and either reject the idea completely or take the child to the eye doctor with full expectation of finding nothing wrong and confirming their own wishful thinking. There are parents who become very much upset at the notice, fear the worst, and rush the child to the eye doctor. A few are panicky about the possible legal results of not doing as the slip requests, especially if it is one that contains a section for parent and doctor to sign and return to the school. This type of blank probably gets action more often than the simple notice. Finally there are the parents who disregard the notice completely.

When the child fails the screening test and goes to the doctor as the report slip requests, both parents and teachers think of glasses as the inevitable result. If the child returns to school with glasses and exhibits a noticeable improvement in achievement the teacher is satisfied and the parents are reconciled. However, glasses only keep the eye in focus while being worn. They do no good in the desk or in the school bag. Even when worn they do not make the eyes more sensitive and it is not at all uncommon for a child to have correct glasses which do not raise his vision, mainly because he lacks the necessary visual sensitivity. Teachers and parents do not usually realize this and expect the child with glasses to be able to compete fully with normally seeing classmates. It is a good plan to test pupils again while wearing their new glasses to see if their vision has been brought up to the same level as most of the other members of the class. If it has not the child should be given appropriate consideration in tasks involving use of the eyes. Many eye conditions do not require the use of glasses, even when there is troublesome visual impairment. Sometimes when the doctor says that glasses are not necessary one or more of these conditions exist. The doctor may think it best to attack the trouble in some other way, such as through medicine, surgery or orthoptics.

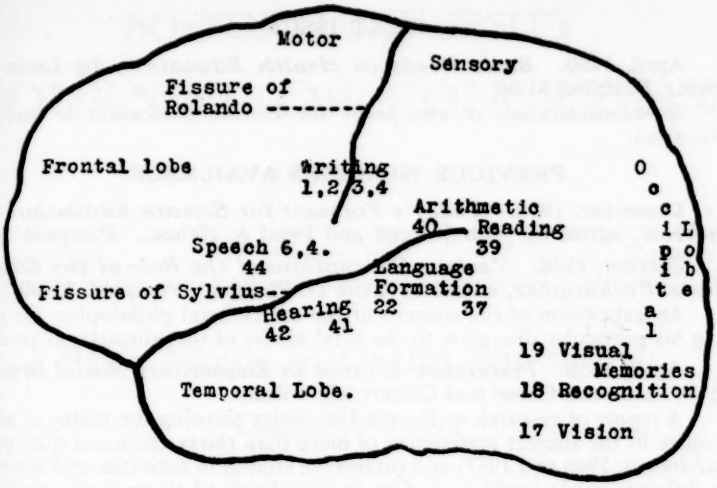
---

[4] Eames, T. H., "When a Child Fails the School Vision Test," *Elementary School Journal, XLIII*, April 1943, pp. 478–480.

Median Measurements of Eye Conditions of School Children

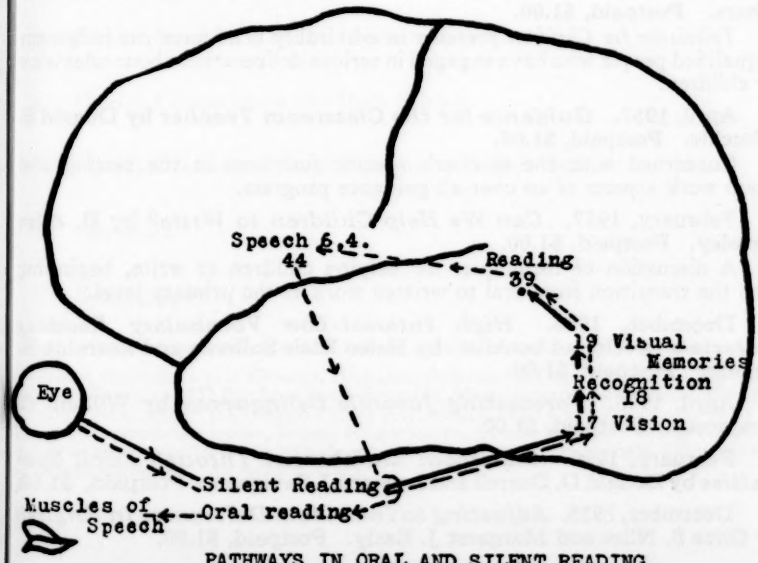
Based on 474 unselected cases

	Age	*Median*
1. Visual Acuity	5 through 17	20/20
2. Refraction	5 and 6	0.75 diopter hypermetropia.
	7 through 13	0.50 diopter hypermetropia.
	14 through 17	0.00 (emmetropia)
3. Coordination		
a. Distant vision	5 through 17	Orthophoria.
b. Reading distance	5 through 8	Orthophoria.
	9 through 17	1 prism diopter exophoria.
4. Adduction	5	10 prism diopters.
	6 through 17	12 prism diopters.
5. Accommodation (P.P.)	5 through 7	no data.
	8	15 diopters.
	9	14 diopters.
	10 through 17	12 diopters.



THE BRAIN

The language functions are located in a general way with the tissues adjacent to the various areas participating to a greater or lesser extent. These centers are intimately connected by association pathways. Areas are numbered according to Brodmann's method.



PATHWAYS IN ORAL AND SILENT READING